

REMARKS

Favorable reconsideration is respectfully requested.

The claims are 16 to 23. Claim 16 is currently amended.

The amendment to the alkyl group length in claim 16 is supported by page 5, lines 8-12 of the specification. The cited section of the specification explains that the alkyl chain has a regular arrangement as in an alkane crystal. In order to have this regular arrangement, it is known in the art that alkyl chains require a certain degree of length i.e., eight or more carbon atoms. The remaining amendments to claim 16 are minor and self-explanatory. Accordingly no new matter is added and entry of this amendment is respectfully requested.

Claim Rejections – 35 U.S.C. § 112

Claims 16 to 23 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. Applicants respectfully traverse.

1. “Layered”

The Examiner contends that the term “layered” is unclear because the layered alkylsiloxane can be a liquid at room temperature.

In response, applicants point out that the term “layered” would be well understood by one of ordinary skill in the art. As an example of “layered compounds”, layered silicates that are a type of clay mineral, and layered niobates and layered titanates which are types of semiconductor compounds are all well-known in the art. Layered silicates have a structure in which a plurality of silicate sheets are laminated. The same is true for layered niobates, etc. In addition, the structure of layered compounds in which a plurality of two-dimensional sheets (the thickness thereof being about 1 nm) are laminated with each other, is known as a “layered structure” in the art.

In the layered alkyl siloxane of the present invention, alkyl siloxane sheets are laminated with each other so as to constitute a layered structure. The alkyl siloxane sheet has a several

hundred nanometer length in a two-dimensional direction with a thickness of about 1 nm being typical.

Attached Exhibit 1, Figure 1 shows a conceptual view of the cross-section of the layered alkyl siloxane of the present invention. In Exhibit 1, Figure 1, three siloxane sheets are shown which constitute “layers”. Alkyl chains form covalent bonds with Si in the siloxane sheet and extend from both sides of the siloxane sheet. Exhibit 1, Figure 2 shows a conceptual perspective view of a layered alkyl siloxane. As shown in Exhibit 1, Figure 1 and Figure 2, the alkyl siloxane sheets of the present invention are laminated with each other. Therefore the term “layered alkyl siloxane” is appropriate and would be clear to one of ordinary skill in the art.

The fact that a layered structure is present is confirmed by X-ray diffraction (XRD) results. Attached Exhibit 2, Figure 3 shows an example XRD pattern of the layered alkyl siloxane in which R is a non-branched alkyl group of 18 carbon atoms. The XRD pattern indicates a layered structure with a plane interval of 2.8 nm. The reflection of the lowest angle side in the XRD pattern indicates the plane interval. In Exhibit 2, Figure 3, reflections at 1/2 fold and 1/3 fold of the plane interval can also be observed due to the layered structure. Although not shown, the plane interval of the layered structure is 2.6 nm in the case of the layered alkyl siloxane in which R is a non-branched alkyl group of 16 carbon atoms. Exhibit 2, Figure 4 is a TEM image of layered alkyl siloxane. About 100 nm of a sheet-like compound can be observed.

The Examiner contends that the term “layered” is unclear in view of the melting point of the layered structure. In reply, the thermoplastic layered alkyl siloxane of the present invention forms a layered structure at a temperature below the melting point and the layered structure collapses upon melting. However, a layered structure is formed reversibly when cooled to a temperature below the melting point, which is a notable feature of the present invention.

The melting point of the thermoplastic layered alkyl siloxane can be regulated by the alkyl group (R) or the degree of cross-linking of the siloxane sheet. For instance, in the case of non-branched alkyl groups (C_nH_{2n+1}), the melting point will be changed by the carbon number n as exemplified in the attached Exhibit 4, Table 1.

The Examiner also contends that the term “layered” is unclear because the layered alkyl siloxane can be liquid at room temperature.

In reply, the term “layered” is not unclear because the layered alkyl siloxane can be liquid at room temperature. In this regard, as shown in Exhibit 4, Table 1, the alkyl siloxane may be solid (e.g., $n=16$ or 18 in Table 1) or liquid (e.g., $n=12$ in Table 1) at room temperature (25°C). The solid forms a layered structure at room temperature. The liquid does not form a layered structure at room temperature. However, as stated above, the liquid is “capable” of forming the layered structure at a temperature below its melting point. The formation of the layered structure is reversible. Therefore, the thermoplastic layered alkyl siloxane is in fact properly termed a “layered alkyl siloxane” as recited in the claims. The layered alkyl siloxane of the present invention can suitably be used in a melt molding process by utilizing the flowability at temperatures above the melting point.

From the discussion above, the term “layered” therefore clearly describes the alkyl siloxane of the present invention to one of ordinary skill in the art. Withdrawal of this rejection is respectfully requested.

2. Formula in claim 1

The Examiner also contends that the formula in claim 1 renders the claims indefinite. Applicants respectfully traverse this rejection as well. The formula of claim 1 is currently amended to express the composition more clearly in accordance with the Examiner’s comments in the Office Action. In the formula, x is a ratio of Si atoms bonded with four oxygen atoms (hereinafter SiQ) with respect to total Si atoms.

In the case of $x=1$, $z=1$, the Si bonded with R (hereinafter SiT) is bonded with three oxygen atoms. When these three oxygen atoms are cross-linked, the coefficient of oxygen bonded with SiT is 1.5. Also, a coefficient of oxygen bonded with SiQ is 2. In practice, some of the oxygen atoms are not cross-linked and exist as OL (e.g., silanol group). Therefore, in the formula the coefficient of oxygen increases by $\frac{1}{2}$ fold with respect to the coefficient of L.

Attached Exhibit 3, Figure 5, shows the structure in the case of $x=2$, $z=2$, and L is H. In this case the formula is $(\text{RSi}_3\text{O}_{6.5}\text{H}_2)_m$.

In the case of $x=1$, $z=1$, the formula is $\text{RSi}_2\text{O}_4\text{L}$ (which is the same as before the current amendment). The Examiner argues in the Office Action that the correct formula is $\text{RSi}_2\text{O}_2\text{L}$ in this case. However the Examiner is mistaken. In Exhibit 3, Figure 6 (when $x=1$, $z=1$, and $\text{L}=\text{H}$), the upper left Si forms $\text{RSiO}_{3/2}$ and the upper right Si forms $\text{SiO}_{3/2}\text{OH}$. Accordingly, the coefficient of oxygen is 4. That is, $3/2$ (oxygen bonded with the upper left Si) + $3/2$ (oxygen bonded with the upper right Si) + 1 (oxygen of OH group bonded with the upper right Si).

For the reasons given above, the rejection under 35 U.S.C. § 112 is untenable and withdrawal of the rejection is respectfully requested.

Claim Rejections – 35 U.S.C. § 102/103

Claims 16 to 18, 20, 22, and 23 are rejected under 35 U.S.C. § 102(b) as being anticipated by Hyde (U.S. 2,486,162). Claims 16 to 23 are rejected under 35 U.S.C. § 102(e) as being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Hayashi et al. (U.S. 6,495,264). Applicants respectfully traverse each of these rejections.

1. Hyde

In the current amendment of claims, R is defined as an alkyl group of 8 or more carbon atoms. This element of the presently claimed product is not disclosed or suggested by Hyde and is connected to several features of the present invention. This includes the layered structure, the melting property at near room temperature, and reversible formation of the layered structure from the liquid state.

The Examiner argues that Hyde discloses a large number of Examples and that the presently claimed layered alkyl siloxane could be produced by Hyde because a similar process to that used in the present invention is employed. However the products in Hyde are not identical with those of the present invention. The products of Hyde do not have the layered structure with a melting point near room temperature as presently claimed.

For instance, in Example 2 of Hyde cited by the Examiner, only methyl groups are mentioned. However, in the layered alkyl siloxane of the present invention the alkyl chains are regularly aligned as shown in Exhibit 1, Figure 1. This regular alignment of alkyl chains will retain a layered structure and requires a certain degree of alkyl chain length, i.e., 8 or more carbon atoms. See claim 1. On the other hand, the methyl groups in Example 2 of Hyde would not be capable of forming a regular alignment because the intermolecular forces between methyl groups is small and insufficient to form regular alignment. This is the reason why the compounds of Hyde become liquid.

In the case of layered alkyl siloxane, the van der Waals forces must work to suppress the thermal motion of the alkyl chains (rotation of the C-C bond) between the alkyl chains. When the alkyl chains are long enough (i.e., 8 or more carbon atoms), the thermal motion is suppressed and the long alkyl chains will form the so-called *trans*-configuration and align regularly. Accordingly, the layered structure will be formed. On the other hand, the layered structure will not form when the alkyl chains are not long enough to exhibit sufficient van der Waals forces. To exhibit van der Waals forces between the alkyl chains, an alkyl chain of more than 8 carbon atoms is necessary.

In Example 2 of Hyde, methyl group is used. The van de Waals forces between methyl groups is too small to form regular alignment therebetween. The thermal motion of the methyl groups will be dominant and inhibit the formation of regular alignment. Therefore, the layered structure cannot be formed.

All of the compounds in the Examples of Hyde are thus unsuggestive of the layered alkyl siloxane compounds of the present claims. One reason is that most of the Examples do not use long alkyl chains, i.e., 8 or more carbon atoms as the alkyl group, as discussed above. Another reason is that even if long alkyl chains are used, Hyde does not use compounds having the SiO_4 unit as a starting material and therefore the synthetic process is different from that of the present invention.

For instance, Example 41 uses dodecyl silicon trichloride (alkyl chain of 12 carbon atoms), however the ratio of dimethyldiethoxy silicon is too high and the dodecyl group will not be capable of regular alignment. Accordingly a layered alkyl siloxane is not obtained.

Hyde's Example 68 also uses dodecyl silicon trichloride, however the product is a thermosetting material. This is because the solvent is volatilized during the synthetic process and the reaction conditions required for aligning long alkyl chains is lost. The steric hindrance of the øMeSi(OEt)_2 also inhibits the alignment of the alkyl chains.

Accordingly, the product of Hyde et al. is unsuggestive of the presently claimed product and withdrawal of this rejection is respectfully requested.

2. Hayashi et al.

Hayashi et al. uses alkyl groups with carbon atoms of 1 to 5. See e.g., column 3. This is outside the range recited in claim 1. Accordingly, the product is clearly different from and unsuggestive of that of the presently claimed invention. The Hayashi et al. product therefore does not have the thermoplastic property of a layered alkyl siloxane of the present invention.

Withdrawal of this rejection is therefore respectfully requested.

Conclusion

No further issues remaining, allowance of this application is respectfully requested. If the Examiner has any comments or proposals for expediting prosecution, please contact the undersigned at the telephone number below.

Respectfully submitted,

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June 16, 2008

Attachments: Exhibits 1-4

Fig.1

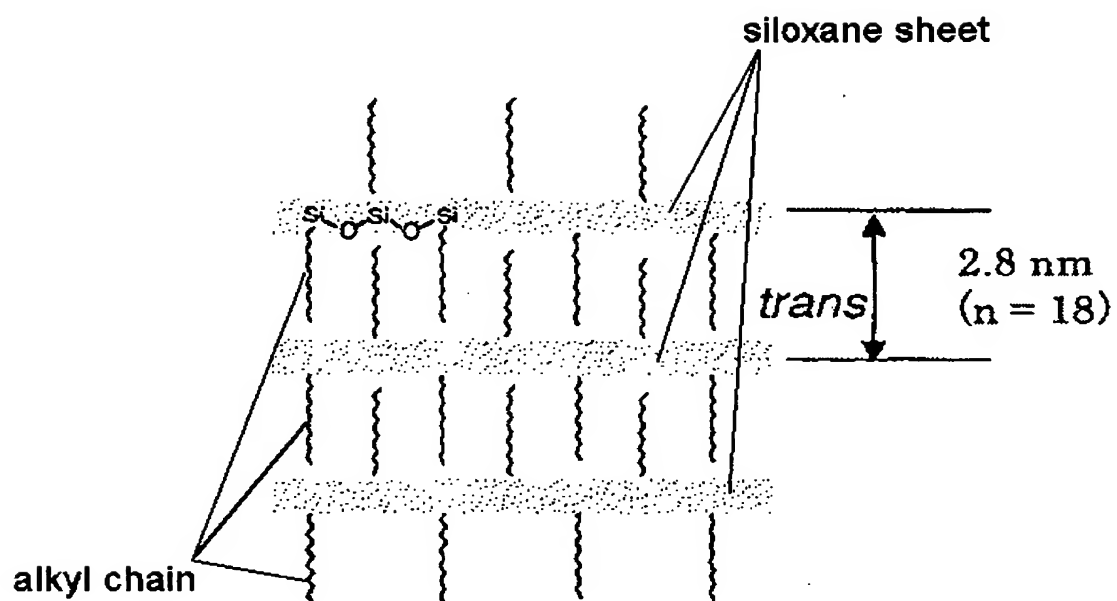
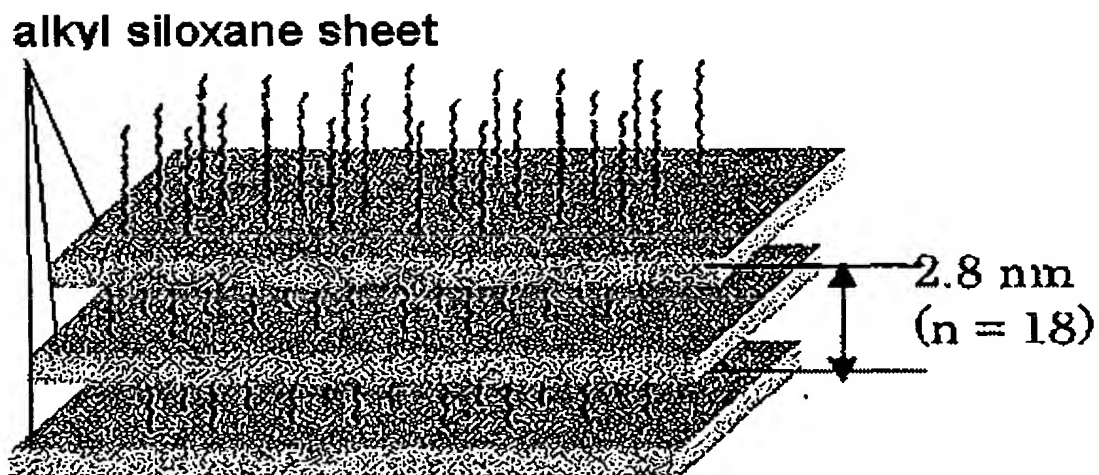


Fig.2



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Fig.3

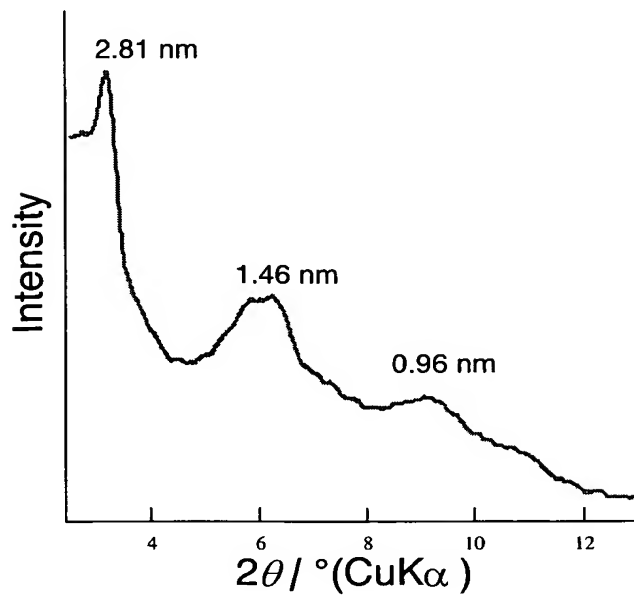


Fig.4

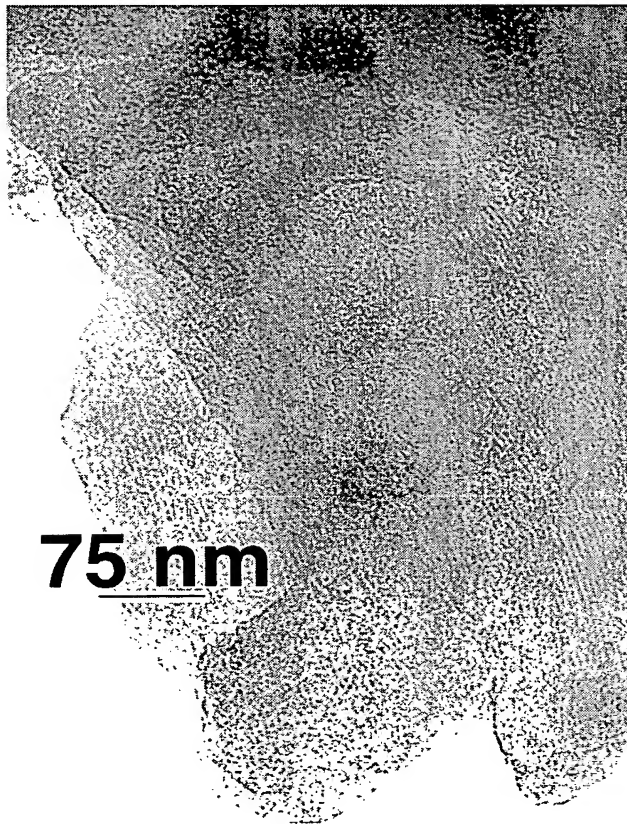


Fig.5

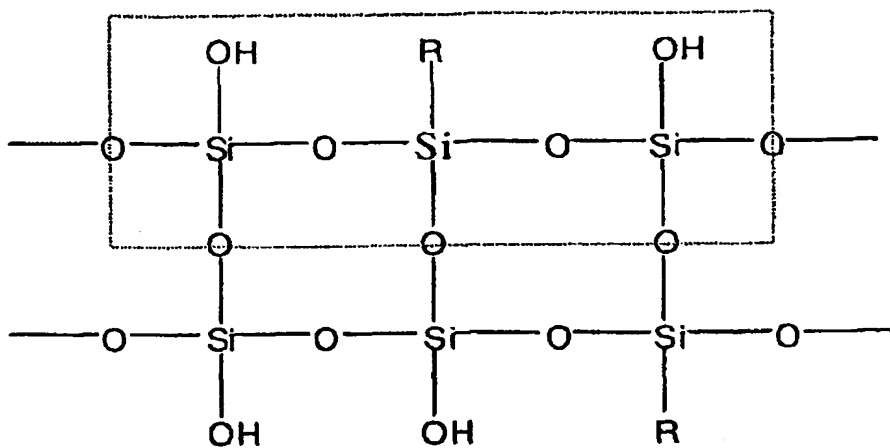
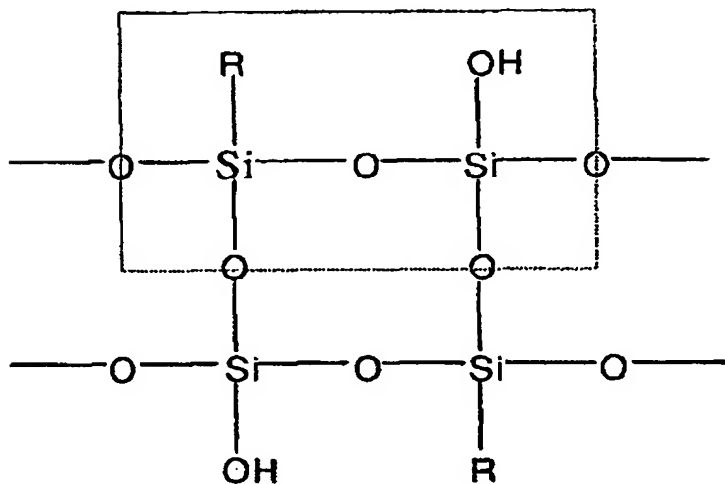


Fig.6



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Table.1

The relationship between alkyl chain length n and melting point

n	melting point (°C)
12	-30
16	37
18	45